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STATE OF ALASKA

William A. Egan, Governor

ANNUAL REPORT OF PROGRESS, 1965 - 1966

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-7

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
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INTRODUCTION

This report of progress consists of Job Segment Reports conducted under the State of Alaska Federal Aid in Fish Restoration Project F-5-R-7, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 18 separate studies. Some are specific to certain areas, species or fisheries, while others deal with a common need for information. Each job has been developed to meet the needs of various aspects of the State's recreational fishery resource. Seven jobs are designed to pursue the cataloging and inventory of the numerous State waters. These jobs, which are of a continuing nature, will eventually index the potential recreational fisheries. Four jobs are directed toward specific sport fish studies. These include specialized efforts toward the anadromous Dolly Varden of Southeastern Alaska, the silver salmon in Resurrection Bay, the king salmon stocks on the Lower Kenai Peninsula, the king salmon stocks in Upper Cook Inlet, and the Arctic grayling of the Tanana River system.

The statewide access program is developing rapidly. Our efforts in investigating existing and potential recreational sites and access has resulted in favorable action being taken on our proposals and recommendations submitted to the land management agencies at both the State and Federal levels.

The remaining jobs included a specialized creel census effort in Southeastern, an egg-take program designed to establish indigenous egg-take sources, and evaluation of the Fire Lake system.

Three special reports have been completed from past studies on the Dolly Varden study. These appear in the Department's "Research Report" series and are a direct result of the Federal Aid In Fish Restoration Program. To date, the following reports have been published: Research Report No. 3, "Some Migratory Habits of the Anadromous Dolly Varden Salvelinus malma (Walbaum) in Southeastern Alaska," 1965, Robert H. Armstrong; Research Report No. 4, "Annotated Bibliography on the Dolly Varden Char," 1965, Robert H. Armstrong; and Research Report No. 5, "Age and Growth of Anadromous Dolly Varden Char Salvelinus malma (Walbaum), in Eva Creek, Baranof Island, Southeastern Alaska," 1966, David W. Heiser.

The material contained in this progress report is often fragmentary in nature. The findings may not be conclusive and the interpretations contained herein are subject to re-evaluation as the work progresses.

Volume 7 Report No. 16-B

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No.: F-5-R-7 Title: Investigations of the Tanana River and Tangle Lakes Fisheries: Migratory and Population Study.

Job No.: 16-B

Period Covered: June 1, 1965 to February 28, 1966.

ABSTRACT

During the 1965 field season 1,560 grayling were tagged, the majority of them in the Tangle Lakes system. Tangle Lake tag recoveries indicate some fish remain in or near the deep lakes while other fish move to the shallow portions of the system for June and July and then begin to move back to deep water. Delta Clearwater River recoveries indicate some upstream movement, downstream movement and, for short tag to tag-recovery intervals, no movement phenomena during the summer. The recoveries also indicate immigration from the Goodpaster River and Clearwater Lake. Evaluation of the current tagging tools indicates an effective technique. Growth analysis indicates an inverse relationship between length and the yearly growth increment. Population estimation techniques were evaluated. Tagged to untagged ratios were examined using data from both the crew and anglers, and by direct enumeration by free floating downstream. In the clear streams commonly frequented by grayling, snorkel and SCUBA diving techniques appear to be readily utilizable and accurate. Extensive efforts were made to investigate spawning dates and areas. Grayling egg counts show no development before 10.5 inches and indicate a direct relationship with size. Specimens and spawning data were collected from both Fielding Lake and the Tangle Lake systems. The overwintering study revealed a population of grayling in late October that fed heavily on salmon eggs at the confluence of the Delta Clearwater-Tanana River.

RECOMMENDATIONS

1. Continue the study concerning the spawning habits and requirements in the Tanana drainage, primarily Fielding Lake, Tangle Lakes, and the Chatanika River. Investigate spawning timing, spawning frequency, fecundity, and environmental requirements.

2. Initiate population estimates by area to enable yearly comparisons, using the various investigation tools to obtain a utilizable estimate.

3. Continue the tagging and tag-recovery program to further document the migration movement tendencies in the Tangle Lake system and the Delta Clearwater-Goodpaster system.

4. Initiate the tagging and tag-recovery program in the Chena River to correlate the movements and migration phenomena to water characteristics that are being investigated by the Alaska Water Laboratory.

OBJECTIVES

1. To investigate the early life history, spawning requirements, spawning timing, environmental requirements, and fecundity of grayling in the Tanana drainage.

2. To investigate the populations of the Delta Clearwater River, Goodpaster River, Richardson Clearwater River, and Tangle Lakes to permit yearly comparisons.

3. To further document the migration movements of grayling in the Tangle Lakes and continue to determine the importance of the in-migration of grayling in streams such as the Delta Clearwater River.

4. To determine the movements of grayling in the Chena River and, if possible, relate these movements to environmental characteristics.

5. To compare growth rate of the grayling of Tangle Lakes to the grayling of the Delta Clearwater River.

TECHNIQUES USED

Three tools were used to capture the fish: seine on smooth stream bottoms with less than four feet of water (principally in Tangle Lakes); gill net in deep or dirty water; rod and line in areas of high fish concentration where effective seining was impossible.

The bag seine (55 feet long, 6 feet deep, with 1/4-inch mesh) was the most desirable tool because in restricted areas large numbers of fish could be captured rapidly. It is estimated that approximately one-half of the fish were captured in this manner.

The second tool, rod and line, was utilized to capture approximately one-half of the fish. From the standpoint of time utilized, fly fishing and occasionally spin fishing accounted for roughly two-thirds of the total effort by all tools. Fly fishing accounted for approximately 95 percent of the rod and line effort while spinning with lures was utilized on those occasions when fish could not be taken by flies or could not be reached by fly rods.

Gill netting was rarely used because in most instances seine or fly fishing could be used in the areas. In addition, fish captured in the gill net were often injured and sometimes killed. Only 17 fish were caught and tagged in this manner.

Once captured, the fish were placed and held in a wire live car (2 feet wide, 2 feet deep and 4 feet long) until a minimum number of fish (15) were collected. The fish were then anesthetized with Tricaine Methanesulphonate (MS-222), tagged ventrally between the pectoral and pelvic fins using a yellow subcutaneous tag, and released at the site of capture. When released, the immobilized fish were placed in a backwater area where water current would not carry them downstream, and any immediate mortalities could be observed.

Each captured fish was tagged and the following information recorded: the tag number, the area and date the fish was captured, and the fork length of the fish to the closest tenth of an inch.

A scale sample was taken from the fish's left side, lateral and adjacent to the insertion of the dorsal fin. The scales were placed in a coin envelope on which the tag number had been recorded.

To insure a higher degree of accuracy, all recoveries in this report were project crew recoveries. Sportsmen recoveries will be incorporated into subsequent reports involving movements and migration trends. The latter recoveries were made incidental to the tagging efforts that continue during the summer or during short periods of creel census.

FINDINGS

Tagging Totals and Recovery Totals

A total of 1,560 fish was tagged, and 139 tagged fish were recovered during the 1965 field season. The majority of the fish was tagged (1,206 or 77%) and recovered (112 or 80%) in the Tangle Lake system (Table 1). Considerable effort was expended in this area; however, the primary reason for the large numbers being tallied here was the ability to effectively use the seine at several different sites in the system. The Delta Clearwater also received a large amount of crew effort with 310 (20%) fish tagged and 26 (19%) fish recovered. Here, as in the remaining areas, rod and line were used as the capture tool.

TABLE 1 - Grayling Tagging and Recovery Totals from the Tanana River Study Areas by the Tagging Crew in 1965.

	Total Tagged	Total Recovered
Tanana River	10	No Recoveries
Richardson Clearwater	13	No Recoveries
Goodpaster River	21	1
Delta Clearwater River	310	26
Tangle Lakes System	1,206	112
TOTAL	1,560	139

Delta Clearwater Migration Movements

The tag recoveries of the Delta Clearwater River show movements both upstream and downstream, with some fish exhibiting no movement (Table 2). The fish showing no movement were recovered within ten days after release (three of the four recovered). Consequently, the four fish that exhibit no movement would be biased due to the short tag to tag-recovery interval.

TABLE 2 - Inter-stream and Intra-stream Movements of Grayling in the Tanana River Drainage from Recoveries made by the Field Crew in 1965.

Recovery Area		Tag Area and Year
Delta Clearwater River		
1		Tag data jumbled (1961)
1		Goodpaster (1964)
1		Clearwater Lake (1962)
9		Delta Clearwater River (1960 through 1964)
10*		Delta Clearwater (1965)
22	TOTAL	

No. Fish	Date Range	Fork Length at Tagging (in.)
4 No movement	1 from 7/13 to 7/20	11.3
	1 from 7/16 to 7/26	11.8
	1 from 7/11 to 7/26	10.9
	1 from 7/17 to 8/25	9.1
3 Upstream	1 from 6/21 to 7/26	10.5
	1 from 7/20 to 8/18	10.8
	1 from 7/27 to 8/18	10.9
3 Downstream	1 from 7/29 to 8/12	9.0
	1 from 7/17 to 10/13	9.1
	1 from 7/16 to 10/13	11.7
10 GRAND TOTAL		

*Movement listing from the ten fish tagged and recovered in the Delta Clearwater in 1965.

The remaining fish were recovered at least three weeks after being tagged. Three fish exhibited upstream movement from late June and July to mid-August, while three fish showed downstream movements from mid-July to mid-October. The actual period of movement is camouflaged by the long tag to tag-recovery interval. The short, approximately one week, intervals in July could have recorded the actual movement, but those fish apparently were not moving at this time. The downstream tendency corresponds with these data since all downstream migrants were tagged after mid-July, indicating that the phenomenon takes place in August, September and possibly October. However, late September and early October observations have shown that the majority of the fish have already migrated out of the stream. A few grayling may be found in the river, but the number of fish present is markedly smaller than the summer population. The late season observations further limit the movement period to August and early September. The exact movement date for any one year would no doubt be influenced by the prevailing weather conditions for that particular year.

The 1965 recoveries from the Delta Clearwater complex indicate a migration pattern very similar to the patterns illustrated in previous years (Reed, 1961; McKirdy, 1962; Nagata, 1963). The recoveries show that the fish tend to remain in the particular river for the summer season of the tag year, but in the succeeding seasons the fish may be recovered in another stream of the complex. The predominant migration seems to be from the Goodpaster River to the Delta Clearwater and the Richardson Clearwater Rivers. Although not recorded in 1965, movements from the Delta Clearwater and Richardson Clearwater into the Goodpaster River have been documented (McKirdy, 1962). A more comprehensive and inclusive segment report covering the 1960 through 1964 period will be completed this winter season.

Movement - Tangle Lakes System

In the 1965 field season 112 tagged grayling were recovered in the Tangle Lakes system (Table 3). Of the grand total, 94 were tagged in 1964 (84%) and 18 were tagged in 1965 (16%).

Of the 94 tag recoveries from 1964, the majority (56 or 59.6%) returned to or stayed in the area at which they had been tagged a year earlier. Twenty of the fish (21.3%) returned to within two miles downstream from the tagging site while 18 (19.1%) returned to within two miles upstream from the site.

These recoveries indicate that the fish return to the same general area year after year. Some tendency to stray from the precise location is exhibited, but no changes greater than two miles were exhibited from year to year.

Of the 18 fish tagged and recovered in 1965, 12 remained in the same location. However, these fish were tagged in areas immediately adjacent to deep water, i.e., the outlet of Round Tangle Lake (Area B) and the outlet of Upper Tangle (Long Tangle, Area A) at the campground on the Denali Highway. These areas were the destinations of those grayling that moved upstream during the summer season, as is indicated by subsequent analysis.

TABLE 3 - Tagged Grayling Recovered in the Tangle Lake - Tangle River System by the 1965 Field Crew.

TAGGED 1964 - RECOVERED 1965

56 Same location
20 Downstream 1.5-2.0 miles
18 Upstream 1.5-2.0 miles

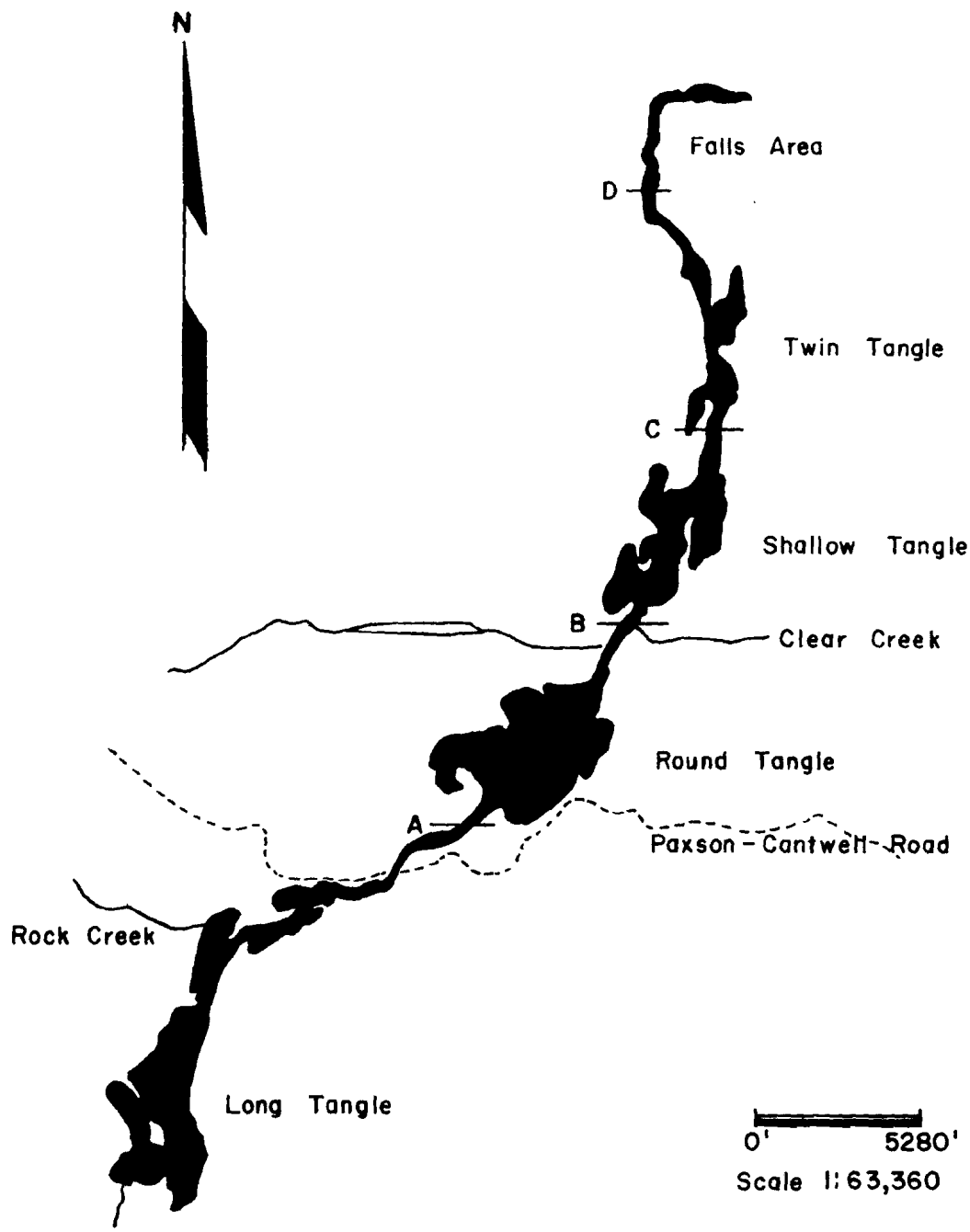
94 TOTAL - 83.9% of total tag recoveries

TAGGED 1965 - RECOVERED 1965

Number of Fish	Upstream Movements Dates/Miles*	Number of Fish	No Movements Dates/Miles*
1	8/5 9/2 17.5 to 14.3	6	7/29 9/13 14.3 to 14.3
1	8/27 9/2 16.0 to 14.3	5	9/13 9/23 14.3 to 14.3
1	9/1 9/12 21.0 to 14.3	1	7/30 9/23 14.3 to 14.3
2	7/31 9/15 8/5 9/14 16.0 to 12.5	12 TOTAL	
1	8/3 9/23 17.5 to 14.3		
6 TOTAL			

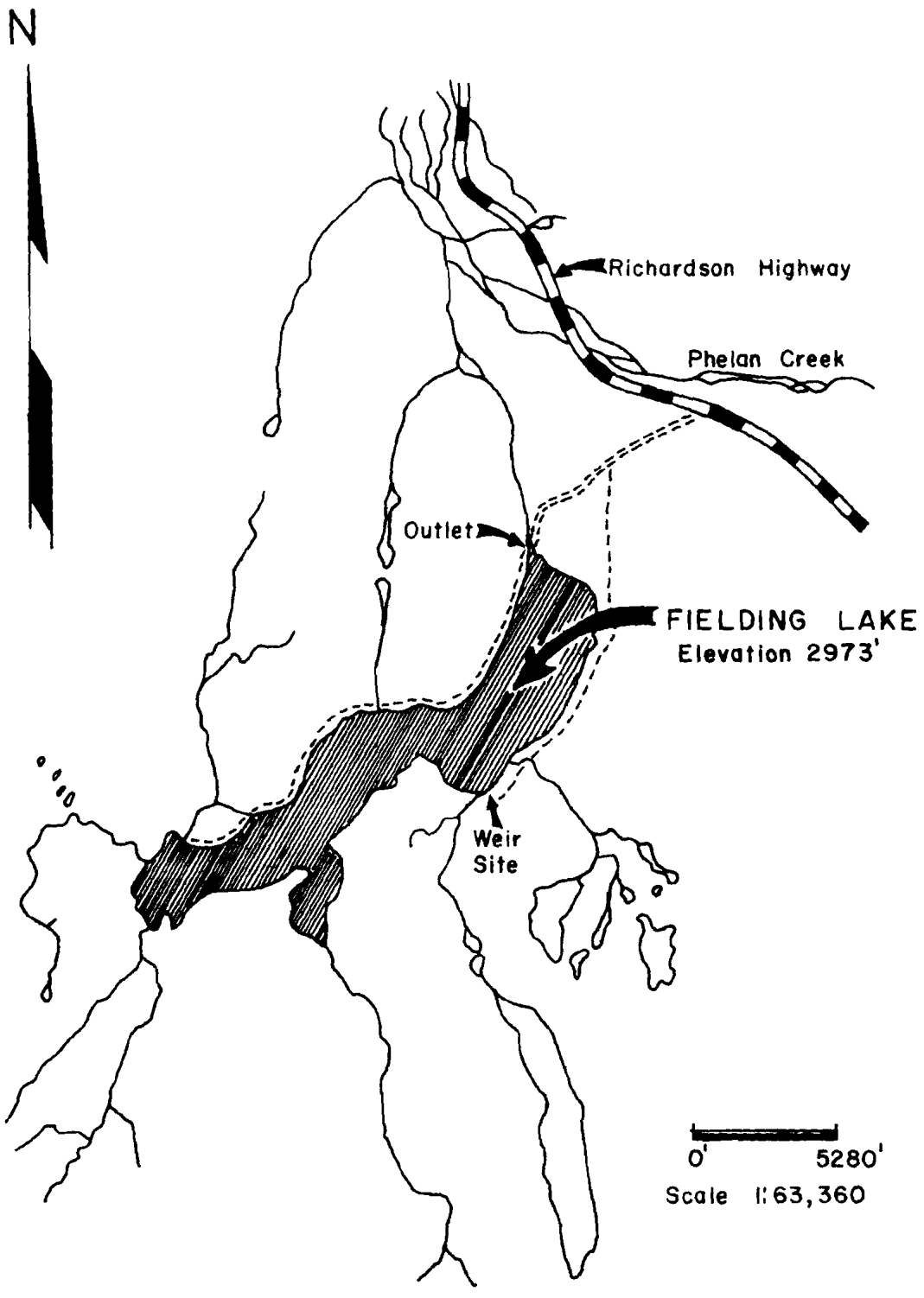
*The miles are measured distances with the mouth of the uppermost tributary of Long Tangle Lake designated Mile 10 (Figure 1).

In 1965, six grayling exhibited upstream movements. These fish were tagged from July 31 to September 1, and recovered from September 2 through September 23. The movements ranged from two to seven miles. These data indicate that the fish move in August and that the tendency is to move upstream to the deep lakes. Downstream movement would result in a loss of these fish to the Tangle Lake fishery since an impassable series of falls (Area D) separate the Tangle Lake system from the upper Delta River (Figure 1). Work in July on the one-mile section of river above the falls and below the outlet of Lower Tangle Lake (Twin Tangle) has revealed an abundance of fish. Grayling were absent during subsequent work in the area in September. Since the fish had virtually vanished from this and



Reproduced From U.S.G.S. Maps; Mt. Hayes A-4 & A-5.

Figure 1. Tangle Lakes



Taken from U.S.G.S. Mt. Hayes (A-4) Quddrangle Map.

Figure 2. Fielding Lake Area

other sections upstream, and the tag recoveries indicate upstream movement, it is concluded that the fish present in July and August in the shallow lakes and river sections move upstream to the deeper holes of the lakes.

No fishermen tag recoveries were used in the Tangle Lake movement analysis because the anglers merely reported the recoveries as coming from Tangle Lakes. This broad classification would not aid the analysis for the Tangle Lakes since the study requires the labeling of specific lakes and streams within the Tangle Lakes system.

The tendency to recover fish that were tagged in previous years in virtually the same location as tagged, leads to the conclusion that the fish behave as separate subgroups within a population. With the fish returning to or remaining in the same location year after year it is conceivable that heavy fishing pressure could decimate one subgroup of the population. With little or no mixing between these subgroups, replenishment of specific stocks would be slow. While this appears to be the trend of the tagged fish that were recovered in subsequent years, a different trend appears in the movement data for the fish that were tagged and recovered in the same year. As Table 3 points out, fish move from the summer habitat to a winter environment; thus, movements, in this case two to seven miles, have been documented. Since the Tangle Lakes proper stretches approximately 10 miles, the movements listed illustrate that a mixing of the population, at least for the winter, does occur. The tendency to return to the same summer area remains, however.

Population Estimates

During the study period, attempts were made to evaluate techniques that will be valuable and usable when estimating the fish population of an area. Three methods were utilized; tag-untagged ratio for the crew, tag-untagged ratio from the fishermen interviews, and limited SCUBA diving.

The first two methods are very similar, the only difference being the source of the data; one data set from the tagging crew and the other from fishermen. Both contain the same biases, one of which would be the tendency to sample only those areas that contain subpopulations or groups of fish that are readily accessible by any one of the capture methods, i.e., rod and line (angler and project crew), seine or gill net. Thus, those areas that are difficult to sample would not be given equal effort, and a partial estimate of the subpopulations within the population of a stream system would be obtained.

The capture tools introduce bias since they capture fish preferentially. The gill net selects only fish large enough to tangle in the strands of the net and those fish that are moving. The seine encompasses those fish inhabiting portions of streams that are relatively accessible and clean of brush and debris, while being shallow enough to permit the investigator to work without endangering himself. This influences the sample since the large fish are often found in deep holes with an abundance of cover while

the smaller fish often frequent the shallower riffles. The rod and line capture technique introduces bias that is extremely difficult to evaluate. A large number of factors affects the sample. Experience shows that the pattern of the fly or the color of the spinner often influences the number and size of the fish that are caught. Another factor that influences the catch is the presentation; i.e., the depth beneath the surface the lure is presented, the type of drift used in the current, the speed and direction the lure is retrieved. While the bias of these facets can not be assessed directly, it is apparent that they do affect the catch, thus further complicating an already extremely complex problem.

A third technique for population estimation was tested. This consisted of free floating and swimming downstream while protected by wet suit, hood, boots, mitts, face mask and using a snorkel tube for breathing. No weight belt was available with the result that submersion was almost impossible, although short periods of partial submersion were accomplished with great difficulty. During these short intervals, the entire width of the river could be observed and the fish were readily identified and counted. Since the observations were clear and concise, the tests were considered successful. It is felt that with the addition of SCUBA gear and weight belts, the investigator would be more mobile, increasing the effectiveness of the technique.

Of the methods discussed, the direct count method by free floating is superior to the other two techniques discussed except when the water is turbid. It permits direct enumeration of the fish found in various ecological niches which could not have been otherwise sampled. It also greatly reduces the introduced biases of the other techniques.

Growth

The growth of the grayling of the Tangle Lakes system was compared with the Delta Clearwater sample (Table 4). When the Tangle Lake sample is compared with the Delta Clearwater data set, two generalizations are evident. Analyzed on a yearly basis, the fish of the Tangle Lakes area appear to grow faster in the first years of life while the Delta Clearwater fish, after reaching eight to nine inches long, grow faster than the Tangle Lake fish (Table 4).

Although these preliminary comparisons are not conclusive, (more investigation is needed) the inference is that the lake-stream habitat provides a more suitable environment for the grayling up to the five- to six-inch range; but after this size the stream habitat enables the larger fish to grow faster in the Delta Clearwater than the Tangle Lake system.

Fecundity Study

The fecundity study specimens were collected from the study area with samples taken from Fielding Lake, Tangle Lake, Delta Clearwater River, and the Tanana Slough. The specimens were collected throughout the field season.

TABLE 4 - Comparison of Tangle Lake and Delta Clearwater Grayling Growth Rates, 1965.

Size Range	Tangle Lakes Yearly Average	Number in Sample	Delta Clearwater River Yearly Average	Number in Sample
4.0 - 4.9	2.00	2		0
5.0 - 5.9	2.45	3	2.0	1
6.0 - 6.9	1.70	6	1.6	1
7.0 - 7.9	1.50	54		0
8.0 - 8.9	1.55	12		0
9.0 - 9.9	1.25	10	1.7	2
10.0 - 10.9			2.3	2
11.0 - 11.9	.6	1	1.0	1
12.0 - 12.9			1.0	1
13.0 - 13.9			.8	2
		88		10

To compensate for the varying egg size from fish to fish, the eggs in a measured volume were counted and the number of eggs per unit volume was then applied to the volume of both egg skeins.

Of the 24 specimens analyzed, two did not show any development (Table 5). The remainder of the fish, ranging from 10.5 to 15.7 inches, either had loose eggs in well developed skeins or had well developed skeins that would spawn at a later date. These fish had a fecundity range of 1,700 eggs to 12,350 eggs with an average of 5,350, which occurs in about the 12-inch size group.

From these data it is apparent that the number of eggs produced increases with the size of the fish. It can be inferred that the 10-inch range (three and four years old) is about the minimum size that the fish will be mature in these areas, physiological maturity being determined by relative size of gonads. These conclusions appear to be valid but, with only 22 specimens autopsied, the conclusions can only be tentative subject to further study in the following field season.

TABLE 5 - Listing of Grayling Egg Count by Fork Length.

Fork Length	Number Eggs	Fork Length	Number Eggs
9.8	0	12.3	5,500
10.2	0	12.4	6,350
10.5	1,700	12.4	6,800
10.7	1,500	12.6	7,750
10.9	1,750	12.8	7,550
11.0	2,000	13.1	7,200
11.1	2,100	13.1	6,950
11.1	2,400	13.3	7,100
11.3	1,950	13.9	7,200
11.6	2,550	14.3	9,050
11.9	3,300	15.1	10,300
12.3	4,200	15.7	12,350

Spawning Dates, Areas, and Spawning Migration

During the months of May and June efforts were made to document the spawning dates, areas, and spawning migration. Fielding Lake with its tributaries (Figure 2), the lakes and streams of the Tangle Lake complex (Figure 1), and several additional tributaries along the Denali Highway to Mile 50 were studied.

The first trip was made on May 19 to Fielding Lake. At this time the lake and tributaries were ice bound. The outlet and a 100-yard semicircle extending into the lake at the outlet were the only open water areas. No fish could be observed at this time. One week later, May 26, the Tangle Lakes and the lake at Mile 50 on the Denali had 6-foot fringes of open water around them, but the tributaries were ice bound. By June 4, the fringes around the lake had widened, some cracks through the ice block in the lake body could be seen, and Rock Creek (Figure 1) had open water in some areas but large ice shelves and ice bridges covered portions of the creek. At this time, the water temperature was 34° and no fish were caught in a gill net or observed in the creek. During the next several days, trips were taken to the MacLaren River, the lake at Mile 50, Upper Rock Creek, and Lower Rock Creek. In all instances no fish were observed.

The first fish were captured on June 18 from a small tributary (Clear Creek) of Tangle Lake (Figure 1). The creek enters the Tangle Lake system at the narrows downstream from Round Tangle Lake. The five fish captured by drift gill net ranged from 12 to 16 inches total length, although smaller fish were observed in the stream. The two females in the sample would not spawn within the next hours as the egg skeins were hard and the eggs were tight.

On June 20, the crew walked around Fielding Lake to the weir site indicated on Figure 2. The lower mile of this tributary was observed with approximately 50 percent of the stream covered by ice bridges. The water temperature was 39°F. In this part of the tributary 14 grayling were observed. Since the observations were taken at mid-day to early afternoon on a clear day, and large ice bridges were present, it is quite possible that many more fish were present under the ice bridges. Several fish when first seen were immediately adjacent to the ice blocks, but upon sighting the observer the fish would dart under the ice cover. Of the 14 observed fish, 4 ranging from 16- to 18-inches long were captured the tributary with both larger and smaller fish seen, but the average appeared to be in the 16- to 18-inch range. Three of the four fish were males exhibiting strong spawning coloration and when pressure was applied to the abdomen milt was exuded. Later, autopsy indicated that the fish were approaching spawning. Examination of the single female revealed that spawning would have taken place within days.

The fish that were captured were lying in shallow riffles, 12 to 18 inches deep, adjacent to deep holes. No sign of courtship or redd digging was observed. However, since the fish were due to spawn, it is probable that this was to be a spawning site.

Additional observations and field trips were made from June 23 through June 29. In the Tangle Lakes area, the creeks were clear of ice but the lakes were still icebound. The lakes had 10 feet of open water around the edges and a few open leads. During this period, grayling were caught and observed in two areas. The uppermost area, the inlet to Upper Tangle Lake, contained large numbers of spawning suckers. Small numbers of whitefish and grayling 10 inches and smaller were in the stream, presumably feeding on sucker eggs. In the second area, Round Tangle Lake, five grayling (9 to 14 inches) were caught off the edge of the ice in one of the bays on the north shore. (From the boat landing, the boat was pulled across the lake ice to the open bays near the outlet.) One male was dripping milt; the other fish, while mature (14 inches), did not show the gonad enlargement.

During the last days of May and the month of June, extensive efforts were made to document the events of the spring spawning run. While mature and ripe grayling were observed in both the Fielding Lake area and the Tangle Lake system, large concentrations of spawning grayling were not observed. Since the mass movement of grayling did not materialize in the areas studied, no definite conclusion can be drawn concerning the spawning dates and the areas utilized.

Overwintering Study

The overwintering study continued on the Delta Clearwater River. Two trips were taken with the first in early October. At this time netting and seining in the Delta Clearwater-Tanana Slough area resulted in the capture of 22 grayling and general observations.

All the grayling captured and those observed were located immediately downstream from salmon redds (primarily chum). Although the salmon frequented different river types from slow, shallow, spring-fed gravel bars in Tanana sloughs to fast, deep riffles and channels in the Delta Clearwater proper, the grayling were present in areas adjacent to salmon. The grayling then were not pursuing ecological niches that were co-incidentally adjacent to spawning salmon, but were present in these habitat types due to the presence of the salmon. (The grayling's dependence upon salmon eggs for food at this time of year is discussed in following paragraphs.)

The number of grayling in the area was determined by direct observation and by drift gill netting. A total of 22 grayling was captured by netting in the Delta Clearwater River proper in areas where the stream bottom was relatively clear of debris. In the Tanana Slough, debris limited the investigation to observations. In one deep hole, a school of grayling numbering at least 50 fish were observed. Deep blueish water, grey stream bottom, and low light intensity limited more accurate determination. Because of the poor conditions for observation and the limited areas in which capture tools could be utilized, it is estimated that the actual number of grayling in the area was much larger than the observations and drift gill netting indicated.

The second trip was made in mid-December. Two short boat trips were made in the campground area under adverse conditions. One large school of fish was observed. The majority of this school of about 200 fish was whitefish. However, several fish were tentatively identified as grayling, although not positively identified because of the low light intensity, the shelves of shore ice, and sporadic amount of flowing slush ice. Several other small schools of fish were also observed.

With the establishment of an overwintering area, at least for early winter, a degree of dependency upon the salmon stocks can be demonstrated by the stomach content study made on the specimens on the trip. Sixteen of the 22 fish captured were retained as specimens. Eleven of these 16 (or 68.7% of these fish), utilized salmon eggs and averaged 54 eggs per individual (Table 6). Eggs were not the only food items found in the stomach but when eggs were present few other items could be found. This indicates a heavy dependence upon the salmon stocks for food at this time of year and results in the hypothesis that the grayling are opportunistic in their overwintering areas. Overwintering may occur wherever adequate water and food items are available.

Parasites

Preliminary examination shows that a significant number of grayling harbor parasites in the stomach. Seven of the 16 fish (43%) carried parasites of two types (Table 6). Two fish possessed acanthocephala (averaging 8 per fish) and five fish harbored nematodes (averaging 19 per fish). None of the parasites were identified. It is possible that more than one species of each group was present. Superficially, the parasites did not appear to be injuring or retarding the fish since little damage was done to the stomach tissue and the fish were proportioned normally.

TABLE 6 - Stomach Food Items and Parasites of Grayling Captured in October, 1965.

Fork Length	Salmon Eggs	Other Food	Parasites
No length	---	31 Trichoptera	12 Acanthocephala
9.5	---	--	3 Acanthocephala
9.7	---	17 Tendipedidae	11 Nematodes
10.2	26	--	--
10.8	49	--	--
11.0	---	--	10 Nematodes
11.0	37	--	--
11.1	5	--	--
11.4	88	Misc. Insects	--
11.8	22	--	31 Nematodes
11.9	19	--	10 Nematodes
12.0	65	Insect parts	--
12.6	177	--	--
13.0	94	--	--
13.0	---	2 Ephemeridae	--
13.3	16	Gravel, twigs	31 Nematodes

Evaluation of the Tagging Techniques

Tagging techniques were evaluated by mortality due to the tagging efforts, tag loss and the detectability of the tagged fish.

Mortality due to tagging efforts normally is not a serious problem as grayling have been found to be quite tolerant to handling and resistant to infection. The only time this does become important is during warm water periods. Usually the water temperatures of the Goodpaster River or Chatanika River are the warmest of the study streams. Even these streams require an extended period of warm weather to raise the water temperature to the 55- to 60-degree level at which the amount of anesthetic (MS-222) administered becomes critical. At this high temperature and above, approximately 200 milligrams of the drug are added to 10 gallons of water. The fish lose equilibrium in roughly two minutes and cannot be retained in solution for more than five more minutes or death may result. At the other end of the temperature range, three times the anesthetic has been added to one-half the water with the result that the fish exhibit abnormal behavior and have difficulty maintaining equilibrium in approximately 10 minutes. These fish have been kept in solution for 30 minutes without suffering any ill effects other than being lethargic. During the 1965 field season eight grayling were killed during this step. However, these grayling may have been injured during capture. All of these fish were killed at Tangle Lakes where a large percentage of the fish were taken by seine. During the seining operation rocks, gravel and sand are often gathered in the bag of the seine along with the fish. When this occurs the fish may be pinched and squeezed between the rocks, causing superficial abrasions and probably internal injuries.

Tag loss is difficult to assess because the tag scars that appear may be from the current tagging year or from past years' tagging. While the scars that are produced in the current year heal within a two- to four-week period, the scar tissue is distinguishable for a minimum of five years after the operation. This is evidenced by the presence of the scar on tagged fish that have been recovered five years after tagging and there is no reason to believe that the scar tissue will be resorbed after this length of time.

The detectability of the tag was checked by a creel census of the anglers. In this instance, 20 different fishermen were interviewed. All were successful in catching fish. Collectively, the anglers had caught 103 fish. Each fisherman was asked how many fish he had caught; then asked if he had caught any tagged fish. After determining if the angler had seen the tags, the fish were examined to see if any tags remained undetected. Of the 103 fish caught, 8 had tags and 7 had been detected by the angler.

It is doubtful that the tagging crew missed any tagged fish because all of the fish that were caught were retained, examined closely for tags, and then tagged. Even if the tag was missed the first time, the consistent placement of the tag and the presence of scar tissue would uncover either the tag or the indication of a previous tagging.

Thirty-two fish that had lost the tags were recaptured. There is no way of determining how many of these fish were tagged in 1965; however, since the scars were not healed, some obviously were tagged in 1965 but others definitely were not.

In the Tangle Lake area, 2,554 fish were tagged in 2 years and 112 fish were recovered in 1965. A total of 20 fish with tag scars was recovered; or 15.2 percent of the total fish recovered in 1965 in Tangle Lakes had tag scars. This percentage is believed to be the highest of any area. The number of fish recovered in the Delta Clearwater River totaled 26 with 2 fish being tag scar recoveries (7.7%). It is possible that the number of small fish tagged in the Tangle Lake system may be related to the increase in the percentage of tag losses. However, this is not apparent as the total Tangle Lake sample averages 8.9 inches while the fish with tag scars average 8.7 inches.

The tagging techniques that are currently being utilized are effective. The mortalities induced by tagging in 1965 were less than one percent, and part of this may be related to capture techniques. The tag loss was estimated to be 15 percent at a maximum and the tags are detectable with virtually all of the tagged fish being discovered by the crew and approximately one out of ten being missed by the angler. Angler recoveries have been accounting for less than 25 percent of the recoveries.

Voluntary Creel Census and Public Information

To expand the public information, a dozen voluntary creel census stations were built and 200 posters were printed. The posters were distributed to the local sporting goods establishments, road houses, etc., along the highway in the study areas. The primary purpose was to inform the sportsmen of the existing program and, in addition,

request the anglers' support and assistance by reporting the area caught, the data caught, and the estimated length of all tagged fish caught.

The voluntary creel census stations were designed to inform the sportsmen of the program and to provide the anglers with readily accessible points at which tag information may be returned. People have admitted carrying the tags around for months before finally turning them in with the result that much of the pertinent information was lost.

With the creel census stations located at boat landing sites, campgrounds, and other heavily utilized areas, it was felt that the fishermen would be constantly reminded of the tagging program and its need of the fishermen's support.

Statistical Analysis of Past Data

Throughout the 1965 period, the data from past years were being prepared and collated for analysis. The existing tag and recovery data were coded (years 1960 through 1964) for IBM analysis. The recovery information was then duplicated preparatory to IBM punching. Recovery listings, growth listings, and subtotals have been returned to the investigator. Initial check of the listings for errors has been started and will continue with the completion of the 1965 completion report; at which time the analysis of existing punched data will commence.

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Public Access to Recreational Waters is Being Assured Through Efforts of the Department.